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Interactive Comment

Interactive comment on "First size-dependent growth rate measurements of 1 to 5 nm freshly formed atmospheric nuclei" *by* C. Kuang et al.

Anonymous Referee #2

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Referee comment to the ACPD article:

First size-dependent growth rate measurements of 1 to 5 nm freshly formed atmospheric nuclei

C. Kuang, M. Chen, J. Zhao, J. Smith, P. H. McMurry, and J. Wang

The MS is well written, and it gives a new step for data analysis of freshly formed particles namely the size dependent growth rate of sub 5 nm particles. In their MS the authors were able to separate size and time dependence in the growth rate. However, before accepting the MS to ACP there are several issues to be considered.

Comments:

1. The title is misleading. Already long ago e.g. Kulmala et al. (2004) and Hirsikko et a., (2005) presented size dependent growth rates in sub 5 nm particles. The better title would be: “Size and time dependent growth rates of sub 5 nm particles”.

2. In my point of view it is missleading to present results in geometric diameter, since the calibrations of key instruments have been made using mobility diameters. Please, use mobility diameters in your text.

3. In my view, the main novelty of the paper is the new method for determining the size-dependence of GR, which is now presented in Appendix A - but currently in a slightly confusing way. If I have understood the method correctly, the determination of Kappa(i) with the method presented is essentially a solution to a system of coupled equations of form A11, but with different Kappas at the upper and lower end of each size interval. And, the iterative procedure presented in the Appendix is a method to solve these equations. If this is the case, and, since this new method is an important part of the paper, I suggest writing these ’core equations’ to the paper itself, and not having them in the Appendix (the description of the iterative solution can be left in the Appendix). Also it is crucial to write the equations in easy-to-understand way.

4. I am somewhat surprised with the error estimates. In my point of view the errors particularly at sub 1.6 nm are much bigger than estimated. The counting efficiency of DEG-CPC is going down. The charging efficiency is unknown. How one is able to have so small error estimates?

5. I am amazed how well the SMPS and Cluster CIMS data match (fig. A4). Is this typical (or some kind of ’best case’ result)? Are some kind of fitting factors used?

6. Is the result in figure 2 a single measurement (a single time)? If yes, does the functional form of Kappa(Dp) vary a lot (at different times)? Would it be possible to plot some kind of a probability density plot of all measured Kappa-values?

7. Which of the presented methods, the steady-state one (Appendix A2.2) or the one

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where time-change dN/dt has been taken into account (Appendix A1.2), has been used to calculate the Kappa(Dp)-results?

8. It would be very good to compare and refer to some earlier papers namely Lehtinen et al. (2004) and Verheggen et al. (2006), which has very similar philosophy behind their growth rate analysis than present paper.

9. When comparing the contribution of sulphuric acid to the growth rate the newest results by Nieminen et al. should be mentioned and compared.

10. The word first has been used too many times. It is proper in some cases, particularly when separation between time and size dependency is presented, but not in other times.

References:

Hirsikko et al. (2005) Annual and size dependent variations of growth rates and ion concentrations in boreal fores. Boreal Env. Res., 10, 357-369.

Kulmala et al. (2004) Intial steps of aerosol growth. ACP, 4, 2553-2560

Lehtinen et al. (2004) Nucleation rate and vapour concentration estimations using a least squares aerosol dynamics method. J. Geophys. Res. 109, D21209, doi:10.1029/2004JD004893.

Nieminen et al. (2010) Sub-10 nm particle growth by vapor condensation – effects of vapor molecule size and particle thermal speed Atmos. Chem. Phys., 10, 9773-9779, 2010

Verheggen et al. (2006) An inverse modeling procedure to determine particle growth and nucleation rates from measured aerosol size distributions. ACP 6, p. 2927-2942.

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